AD-A162 464 SWITCHABLE ZERO ORDER DIFFRACTION GRATINGS AS LIGHT VALVES(U) MASSACHUSETTS INST OF TECH CAMBRIDGE RESEARCH LAB OF ELECTRONICS J MELNGAILIS 11 OCT 85 1/1

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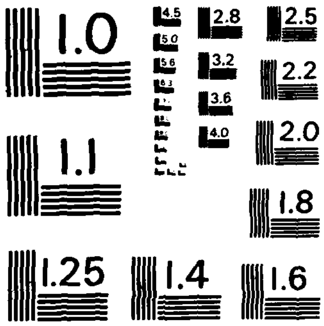

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Semiannual Report

1 April 1985 to 30 September 1985

"Switchable Zero Order Diffraction

Gratings as Light Valves"

Office of Naval Research

Contract N00014-84-K-0073

Submitted by

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October 11, 1985

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During this half year the work on the light valves was completed early, and the remaining funds and time have been directed to a circuit restructuring project. This change was agreed to by both the Office of Naval Research and by DARPA.

a) <u>Description of Research</u>

1. Switchable Zero Order Diffraction Grating as Light Valves:

The goal of this project is to produce a light valve based on the cancellation of the zero order of diffraction. The light valve works by displacement of two facing gratings with respect to one another by half an operating period. The light valve is made of polyvinylidine fluoride (PVF_2) a piezoelectric plastic. It is simple cheap and, in principle, mass producible into arrays to serve as a flat display or as a light modulator in optical signal processing.

Using the optimum conditions for embossing PVF_2 determined earlier. A dozen gratings were fabricated each about $1cm^2$ and of the desired square profile and 1.5 µm depth. The period of the gratings was 3.8µm. Since about $1mm^2$ is needed for each light valve, plenty of grating area was available. A theory of the embossing process was developed using deformation and slip theory. It explains the triangular slip plane which is always observed under the indented part of deeper gratings. This work constituted the master thesis of Ms. Deborah Summa.

Using photolithography techniques and reactive ion etching a number of chevron structures were fabricated from these gratings. A significant achievement on its own is the developoment of a microfabrication technology, usually practiced on ideally flat, rigid, Si wafers, for floppy piezoelectric 9µm thick Saran-wrap-like plastic. The chevron structures thus fabricated served as motion amplifiers to produce the desired displacement of the gratings with respect to one another and to switch the light. Microgluing and microcrimping techniques were developed for attaching the chevrons and the movable grating to the stationary grating.

In assembled structures 150V was applied to the chevron arms (across 9µm thick PVF_2), and motion of 2µm was observed. This is adequate for switching the light valve. The gratings in light valves were aligned with each other using Moire techniques, in both the light transmitting and the light blocking modes. The alignment procedure is quite difficult. In addition, the mounting and attachment of the chevrons after alignment present significant experimental challenge. We have been able to overcome these difficulties and have demonstrated the principle of operation. We have also measured the optical properties of the gratings and developed the principles for fabricating a back lighted display. The principle of operation is sound. However, the practical difficulties encountered in assembling these single light valves leave one pessimistic about fabricating an array. The main body

of this work constituted the Ph.D. thesis of Josephine A. Stein, was presented as a paper at the SPIE meeting in Los Angeles and published in the proceedings.

2. Focused Ion Beam assisted deposition applied to circuit restructuring:

The new added task aims to exploit a recently discovered phenomenon: metal films can be deposited locally with submicron resolution by focusing an ion beam on the substrate in the presence of a local gas ambient, such as WF_6. We aim to exploit this phenomenon to make "jumpers" in integrated circuits after the normal fabrication is complete. This would serve as a repair, or restructuring technique or a fast prototyping technique.

Work done on this task is as follows:

i) A capillary gas feed aimed at the sample has be tested using a flood ion beam at 750V and tungsten deposition from WF_6 has been observed at the mouth of the capillary tube. A liquid nitrogen cooled stage has been used for some experiments, and a thermoelectrically cooled stage has been ordered.

ii) Apparatus is being designed to do similar deposition experiments using an ion implanter.

iii) A rudimentary focused ion beam system which will produce a beam of Ga ions ~1μm diameter at 15 kV is being assembled. This system is being loaned to us by Ion Beam Technologies, Inc.

<u>In the next year we plan to:</u>

1. Develop the techniques for focused ion beam assisted deposition of metallic films and apply them to actual integrated circuit restructuring, repair, and prototyping.

2. Study the deposition parameters, i.e. dependence of deposition rate on gas flux, ion flux, substrate temperature, and ion energy.

3. Develop a model of the process.

<u>List of presentations:</u>

J.A. Stein, J.A. Rajchman, J. Melngailis, and D.A. Summa, "A Display Based on Switchable Zero Order Diffraction Grating Light Valves", SPIE meeting *Los Angeles*, January 24-25, 1985. D.A. Summa, M.T. Tse, and J. Melngailis, "An Investigation on Embossing of Fine Features into Solid Polymer Films", submitted for presentation to Society of Plastics Engineers.

Technical Reports:

"Micromechanical Optical Switch Based on Zero Order Diffraction for Flat Panel Display", by J.A. Stein, Ph.D. thesis Mechanical Engineering MIT, September 1985.

"An Investigation of Forming of Diffraction Gratings in Thin Polymen Films", D.A. Summa, M.S. thesis, Mechanical Engineering, MIT, May 1985.

Publications:

J.A. Stein, J.A. Rajchman, J. Melngailis, and D.A. Summa, Proceedings of SPIE, vol. 526, p. 105.

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